0 Let \( s \) and \( n \) be \( nat \) variables. Here is a refinement.
\[
\begin{align*}
s' &= s + 2^n - 1 \quad \iff \quad \text{if } n=0 \text{ then } ok \text{ else } n := n-1. \quad s := s + 2^n. \quad s' = s + 2^n - 1 \fi
\end{align*}
\]
(a)[12] Prove it.
(b)[3] Insert appropriate time increments according to the recursive measure, and write appropriate timing specifications.
(c)[6] Prove the timing refinement.

1[9] Let \( S \) be a bunch of strings. Using construction and induction, define \( T \) to be the bunch of all strings formed by joining together any number of any strings in \( S \) in any order. (Do not use the \( * \) operator; in effect, you are defining the \( * \) operator.)

2[12] Let \( i \) be an extended integer variable, and let \( t \) be an extended natural time variable. Let \( P \) be a specification such that
\[
\begin{align*}
P &\quad \iff \quad \text{if } i=0 \text{ then } ok \text{ else } i := i-1. \quad t := t+1. \quad P \fi
\end{align*}
\]
What solution for \( P \) does recursive construction give when we start with \( P_0 = t := \infty \)? (Find it, but you do not need to prove that it is a solution.)